GSF®

Geotextile Sand Filter

Montana
Design & Installation Manual

eljen CORPORATION

Innovative Onsite Products & Solutions Since 1970

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www.eljen.com

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Glossary of Terms

A42 Module 48" x 24" x 7" (L x W x H)

Cover Fabric The geotextile cover fabric (provided by manufacturer) that is placed over the GSF modules. Barrier material cannot be substituted.

Design Flow When the number of individual living units on a single or common absorption system is 9 or less, the following table must be used. Sizing is based on individual living units, not collective number of bedrooms. Living units will be considered to have three bedrooms unless otherwise approved.

1 bedroom	150 gpd
2 bedrooms	225 gpd
3 bedrooms	300 gpd
4 bedrooms	350 gpd
5 bedrooms	400 gpd
Each additional bedroom	add 50 gpd

GSF Unit The Eljen Geotextile Sand Filter Modules and the 6-inch sand layer at the base and 6 inches along the sides of the modules.

GSF Module The individual module of a GSF system. The module is comprised of a cuspated plastic core and geotextile fabric.

Specified Sand To ensure proper system operation, the system MUST be installed using ASTM C33 Sand or sand meeting 6.7.3.4.B of the Montana Standards for Subsurface Wastewater, Circular DEQ 4.

ASTM C33 sand will have less than 10% passing the #100 Sieve and less than 5% passing the # 200 sieve. Ask your material supplier for a sieve analysis to verify that your material meets the required specifications.

TABLE 1: SPECIFIED SAND SIEVE REQUIREMENTS

ASTM C33 SAND SPECIFICATION		
Sieve Size	Sieve Square Opening Size	Specification Percent Passing (Wet Sieve)
3/8 inch	9.52 mm	100
No. 4	4.76 mm	95 - 100
No. 8	2.38 mm	80 - 100
No. 16	1.19 mm	50 - 85
No. 30	590 μm	25 - 60
No. 50	297 μm	5 - 30
No. 100	149 μm	0 - 10
No. 200	75 μm	0 - 5

GSF System Description

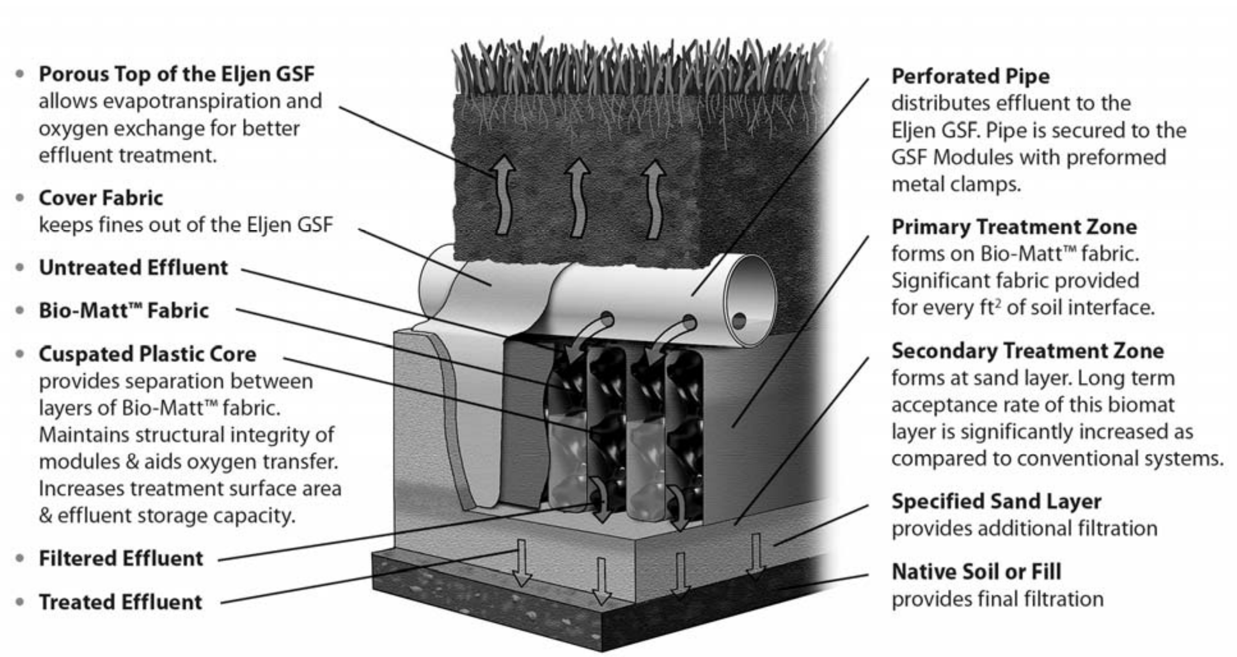
Primary Treatment Zone

- Perforated pipe is centered above the GSF module to distribute septic effluent over and into corrugations created by the cuspated core of the geotextile module.
- Septic effluent is filtered through the Bio-Matt (geotextile) fabric. The module's unique design provides increased surface area for biological treatment that greatly exceeds the module's footprint.
- Open air channels, within the module, support aerobic bacterial growth on the modules geotextile fabric interface, surpassing the surface area required for traditional absorption systems.
- A cover fabric covers the top and sides of the GSF module and protects the Specified Sand and soil from clogging, while maintaining effluent storage within the module.

Secondary Treatment Zone

- Effluent drips into the Specified Sand layer and supports unsaturated flow into the native soil. This Specified Sand/soil interface maintains soil structure, thereby maximizing the available absorption interface in the native soil. The Specified Sand supports nitrification of the effluent, which reduces oxygen demand in the soil, thus minimizing soil clogging from anaerobic bacteria.
- The Specified Sand layer also protects the soil from compaction and helps maintain cracks and crevices in the soil. This preserves the soil's natural infiltration capacity, which is especially important in finer textured soils, where these large channels are critical for long-term performance.
- Native soil provides final filtration and allows for groundwater recharge.

FIGURE 1: GSF SYSTEM OPERATION



1.0 Conditions for Use

1.0.1 ALTERATION OF MODULES: GSF modules shall not be altered by cutting or any other type of physical modification.

1.0.2 WATER SOFTENER BACKWASH: Water softener backwash shall be discharged to a separate soil absorption field meeting all required state codes and local regulations.

1.0.3 SEPTIC TANK OUTLET FILTERS: Eljen requires the use of outlet filters on all tanks including single compartment tanks, up-sized tanks or when the dwelling has a garbage disposal installed.

1.0.4 GARBAGE DISPOSALS: Eljen discourages the use of garbage disposals with septic systems. If a GSF system is to be designed and installed with garbage disposals the following measures must be taken to prevent solids from leaving the tank and entering the GSF system:

- Increase the septic tank capacity by a minimum of 30% *or*
- Installation of a second septic tank installed in series if a multi-compartment tank isn't used

1.0.5 ADDITIONAL FACTORS AFFECTING RESIDENTIAL SYSTEM SIZE: Homes with expected higher than normal water usage may consider increasing the septic tank volume as well as incorporating a multiple compartment septic tank. Consideration for disposal area may be up-sized for expected higher than normal water use.

For example:

- Luxury homes, homes with a Jacuzzi style tubs, and other high use fixtures.
- Homes with known higher than normal occupancy.

1.0.6 SYSTEM PROHIBITED AREAS: All vehicular traffic is prohibited over the GSF system. GSF systems shall not be installed under paved or concreted areas. If the system is to be installed in livestock areas, the system must be fenced off around the perimeter to prevent compaction of the cover material and damage to the system.

1.0.7 ELJEN INSTALLER CERTIFICATION: All installers are required to be trained and certified by an authorized Eljen representative. Contact your local distributor for training information.

1.1 System Design

1.1.1 REQUIREMENTS: GSF systems must meet the local rules and regulations except as outlined in this manual. The Montana State regulations, Montana Standards for Subsurface Wastewater Treatment Systems, Circular DEQ 4 will be referred to as the *guidelines*.

The sizing charts apply to residential systems only and are found in section 1.1.4. Please contact Eljen's Technical Resource Department at 1-800-444-1359 for design information on commercial systems.

1.1.2 NUMBER OF GSF MODULES REQUIRED: The tables found in this manual indicate the minimum number of A42 modules allowed. Systems can always be designed beyond the minimum required number of modules. The minimum design requirements per 150 gpd are 6 A42 modules.

1.1.3 SUITABLE SITE AND SOIL CONDITIONS: The Eljen Modules may be designed for all sites that meet the criteria of the local approving authority.

1.1 System Design

1.1.4 SIZING GSF SYSTEMS:

TABLE 2: MINIMUM BASAL AREA AND APPLICATION RATES

Texture	Percolation Rate (mpi)	GSF System Application Rate (gpd/ft2)	Minimum Basal Area Required				
			2 Bedrooms 225 gpd	3 Bedrooms 300 gpd	4 Bedrooms 350 gpd	5 Bedrooms 400 gpd	Each Additional Bedroom 50 gpd
Gravel, gravelly sand, or very coarse sand	< 3	1.6	144	216	288	360	72
Loamy sand, coarse sand	3 - 5	1.6	144	216	288	360	72
Medium sand, sandy loam	6 - 9	1.2	188	250	292	360	72
Fine sandy loam, loam	10 - 15	1	225	300	350	400	72
Very fine sand, sandy clay loam, silt loam	16 - 30	0.8	282	375	438	500	72
Clay loam, silty clay loam	31 - 50	0.6	375	500	584	667	84
Sandy clay	51 -79	0.266	846	1128	1316	1504	188
Clays, silts, silty clays	80 -120	0.2	1125	1500	1750	2000	250
Clays, silts, silty clays	120+	Not Permitted					

TABLE 3: MINIMUM UNITS REQUIRED PER BEDROOM

Texture	Percolation Rate (mpi)	GSF System Application Rate (gpd/ft2)	Minimum Units Required				
			2 Bedrooms 225 gpd	3 Bedrooms 300 gpd	4 Bedrooms 350 gpd	5 Bedrooms 400 gpd	Each Additional Bedroom 50 gpd
Gravel, gravelly sand, or very coarse sand	< 3	1.6	12	18	24	30	6
Loamy sand, coarse sand	3 - 5	1.6	12	18	24	30	6
Medium sand, sandy loam	6 - 9	1.2	12	18	24	30	6
Fine sandy loam, loam	10 - 15	1	14	18	24	30	6
Very fine sand, sandy clay loam, silt loam	16 - 30	0.8	15	20	24	30	6
Clay loam, silty clay loam	31 - 50	0.6	17	22	26	30	7
Sandy clay	51 -79	0.266	18	24	28	32	9
Clays, silts, silty clays	80 -120	0.2	20	26	31	35	10
Clays, silts, silty clays	120+	Not Permitted					

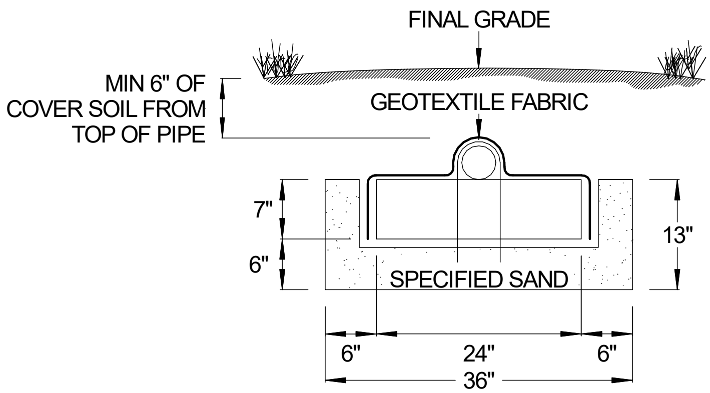
2.0 Trench Design and Installation

2.0.1 ACCEPTABLE METHODS OF DISTRIBUTION: Gravity, dosed and pressure distribution are acceptable.

2.0.2 DEPTH FROM ORIGINAL GRADE: The maximum depth for a subsurface system is 36 inches. The minimum depth is determined by the local approving authority.

2.0.3 GENERAL CROSS SECTIONS

FIGURE 2: A42 TRENCH CROSS SECTION

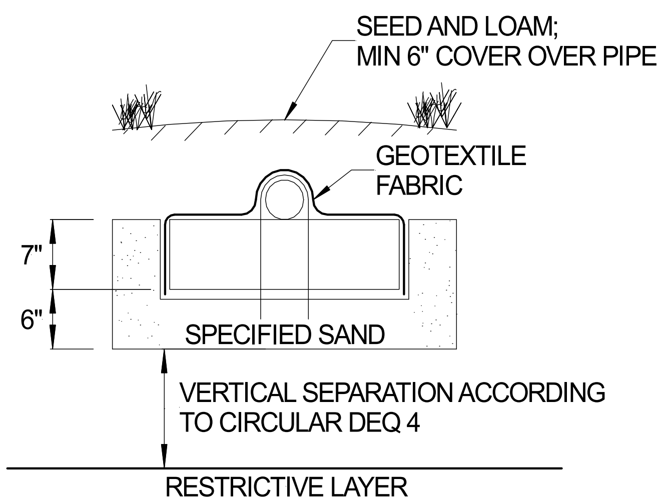


All trenches are required to have a minimum of:

- 6 inches of Specified Sand at the edges of the GSF module.
- 6 inches of Specified Sand at the beginning and end of each GSF Row.
- 6 inches of Specified Sand directly below the GSF module.
- 6 inches of cover soil material above the 4-inch distribution pipe.

2.0.4 VERTICAL SEPARATION TO SEASONAL HIGH-WATER TABLE OR LIMITING LAYER: The guidelines allow for the Vertical Separation from bottom of the 6 inches of sand under the GSF units to the restrictive layer.

FIGURE 3: VERTICAL SEPARATION DISTANCE



2.0 Trench Design and Installation

2.0.5 DISTRIBUTION BOX: Parallel distribution is preferred. Sequential distribution may be utilized for sloping sites.

2.0.6 PARALLEL DISTRIBUTION: Parallel distribution is the preferred method of application to a gravity or pump to gravity system. It encourages equal flows to each of the lines in the system. It is recommended for most trench systems.

2.0.7 TRENCH WIDTH: The maximum trench width is 4 feet with 12 inches of sand at the edges of the unit and a minimum typical width of 3 feet with 6 inches of sand at the edges of the unit.

2.0.8 TRENCH LENGTH: The maximum gravity lateral run shall not exceed 100 feet. If a lateral is supplied from the center, the total length shall not exceed 200 feet (100 feet to each side).

2.0.9 EQUAL LENGTH: Eljen recommends trenches are of equal length in order to provide equal distribution.

2.0.10 SPACING GUIDANCE BETWEEN TRENCHES: Adjacent trenches should be separated by at least 3 feet of undisturbed soil.

2.0.11 DISPERSAL AREA: Dispersal area requirements are met by total length and width of each trench added together. Example: 3 trenches x 3 feet wide x 60 feet = 540 square feet of dispersal area.

2.0.12 MINIMUM SLOPE REQUIREMENTS: Maintain a minimum 2:1 slope or gentler for all slopes off the cell area.

2.0.13 SEPARATE SUBSURFACE REPLACEMENT AREA: There is no requirement for a separate subsurface replacement area.

2.1 Trench Design Example

Trench Example:

House size:	3 Bedrooms
Design Flow:	300 gpd
Soil Description:	Sandy Clay Loam with 20 mpi perc
Absorption Field Type:	Trench

Determine Minimum Basal Area and Units Required
Lookup the minimum basal area from Table 2:

Texture	Percolation Rate (mpi)	GSF System Application Rate (gpd/ft2)	Minimum Basal Area Required				
			2 Bedrooms 225 gpd	3 Bedrooms 300 gpd	4 Bedrooms 350 gpd	5 Bedrooms 400 gpd	Each Additional Bedroom 50 gpd
Very fine sand, sandy clay loam, silt loam	16 - 30	0.8	282	375	438	500	72

Trench Width (either 3 or 4 ft)

3 ft

4 ft

Calculate Minimum Trench Length

Basal Area ÷ Trench Width = Trench Length

$375\ ft^2 \div 3\ ft = 125\ ft$

$375\ ft^2 \div 4\ ft = 93.75\ ft$, round to 94 ft

Calculate Minimum Units Required

(Minimum Trench Length -1) ÷ 4 = Units Required

(125 ft – 1) ÷ 4 = 31 units

(94 ft – 1) ÷ 4 = 23.25 units, round up to 24 units

Calculate Trench Length

Units x 4 + 1 ft system sand at end of trench = Trench Length

31 units x 4 + 1 = 125 ft

24 units x 4 +1 = 97 ft

Final Dimension Layout
(Note: System layout and number of rows will vary based on site constraints)

3 ft Width

Min. Trench Length	125 ft
Trench Width	3 ft
Number of Units	31 A42 Units
Min. System Area	$375\ ft^2$

4 ft Width

Min. Trench Length	97 ft
Trench Width	4 ft
Number of Units	24 A42 Units
Min. System Area	$388\ ft^2$

2.1 Trench Design Example

FIGURE 4: PLAN VIEW –TRENCH SYSTEM

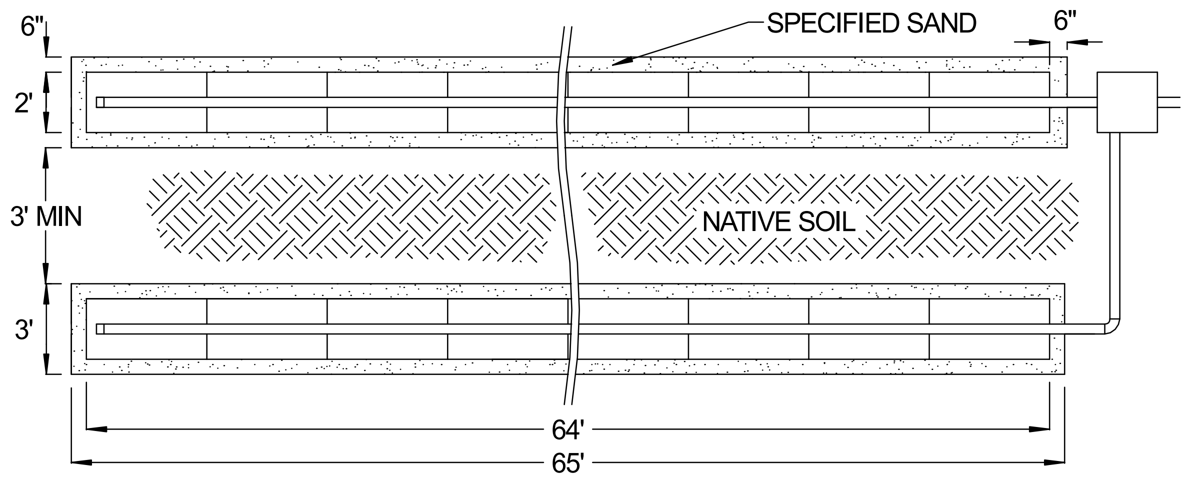


FIGURE 5: SECTION VIEW – TRENCH SYSTEM – LEVEL SITE

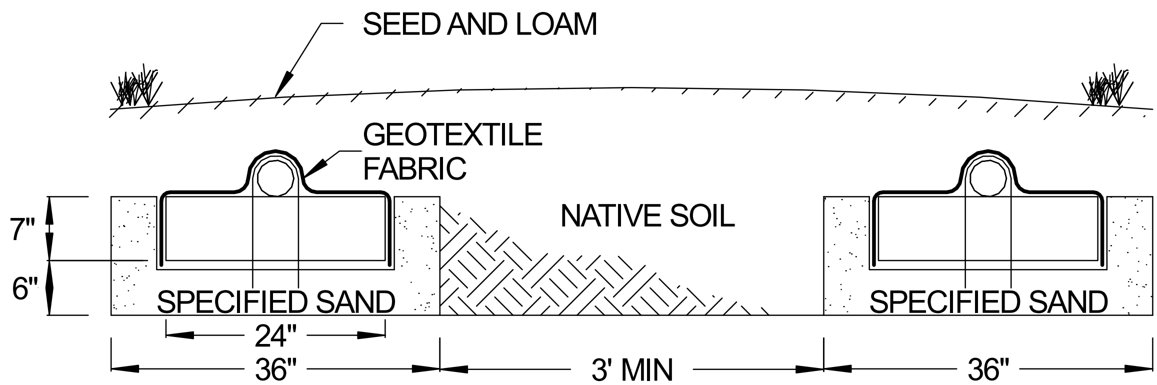
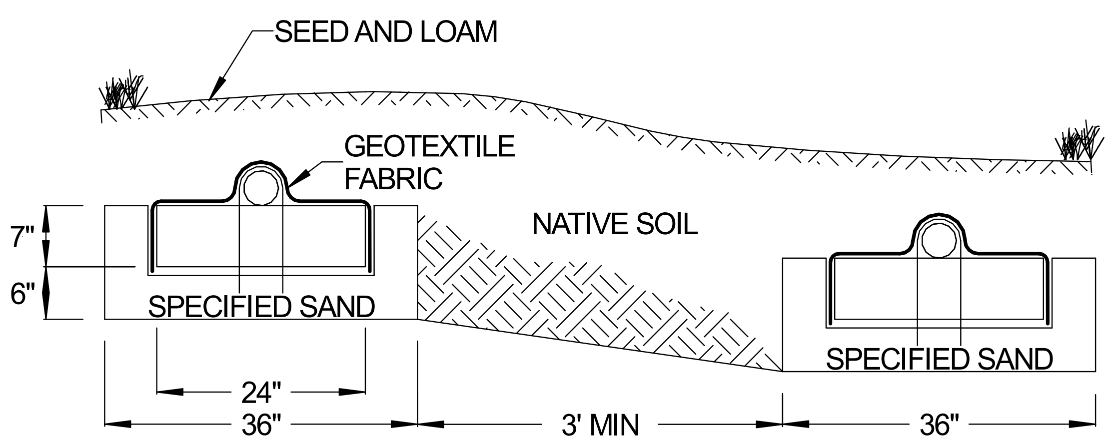


FIGURE 6: SECTION VIEW – TRENCH SYSTEM – SLOPING SITE



2.2 Trench Design Installation Steps

1. Ensure all components leading to the GSF system are installed properly. Septic tank effluent filters are required with the GSF system.

2. Determine the number of GSF Modules required using the trench sizing example.

3. Prepare the site. Do not install a system in saturated ground or wet soils that are smeared during excavation. Keep machinery off infiltrative areas.

4. Plan all drainage requirements above (up-slope) of the system. Set soil grades to ensure that storm water drainage and ground water is diverted away from the absorption area once the system is complete.

5. Excavate the trench; scarify the receiving layer to maximize the interface between the native soil and specified sand.

6. Minimize walking in the trench prior to placement of the specified sand to avoid soil compaction.

7. Place specified sand in a 6” lift, stabilize by foot, a hand-held tamping tool or a portable vibrating compactor. The stabilized height below the GSF module must be level at 6”.

8. Place GSF modules with **PAINTED STRIPE FACING UP**, end to end on top of the specified sand along their 4-foot length.

9. A standard 4-inch perforated pipe, SDR 35 or equivalent, is centered along the modules 4-foot length. Orifices are set at the 4 & 8 o’clock position.

10. All 4-inch pipes are secured with manufacturers supplied wire clamps, one per module.

11. (Pressure Distribution Systems) The pressure pipe orifices are set at the 12 o’clock position as shown in Figure 17. Orifice shields are placed over the lateral. Each pressure lateral will have a drain hole at the 6 o’clock position. Each pressure lateral shall have a clean out at the end of the trench. Refer to Section 6 for guidelines on how to use pressure distribution.

12. ***Cover fabric substitution is not allowed.*** The installer should lay the Eljen provided geotextile cover fabric lengthwise down the trench, with the fabric fitted to the perforated pipe on top of the GSF modules. Fabric should be neither too loose, nor too tight. The correct tension of the cover fabric is set by:
    a. Spreading the cover fabric over the top of the module and down both sides of the module with the cover fabric tented over the top of the perforated distribution pipe.
    b. Place shovelfuls of Specified Sand directly over the pipe area allowing the cover fabric to form a mostly vertical orientation along the sides of the pipe. Repeat this step moving down the pipe.

13. Place 6 inches of Specified Sand along both sides of the modules edge. A minimum of 6 inches of Specified Sand is placed at the beginning and end of each trench.

14. Complete backfill with a minimum of 6 inches of approved cover material measured from the top of the distribution pipe. Backfill exceeding 18 inches over the top of the unit requires venting at the far end of the trench. Use well graded native soil fill that is clean, porous and devoid of large rocks. Do not use wheeled equipment over the system. A light track machine may be used with caution, avoiding crushing or shifting of pipe assembly.

15. Divert surface runoff from the system. Finish grade to prevent surface ponding. Topsoil and seed system area to protect from erosion.

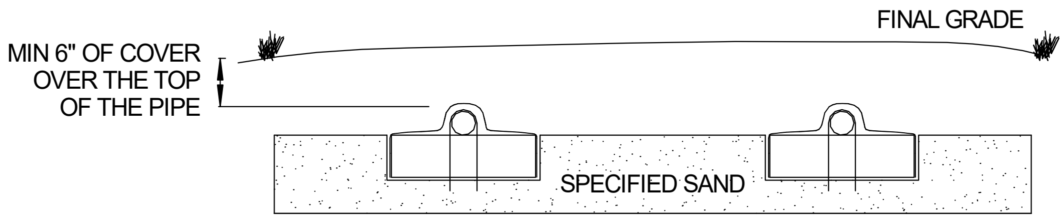
3.0 Bed Design and Installation

3.0.1 ACCEPTABLE METHODS OF DISTRIBUTION: Gravity, dosed and pressure distribution are acceptable.

3.0.2 MINIMUM DEPTH FROM ORIGINAL GRADE: The maximum depth for a subsurface system is 36 inches. The minimum depth is determined by the local approving authority.

3.0.3 GENERAL CROSS SECTION

FIGURE 7: BED CROSS SECTION



All bed systems are required to have a minimum of:

- 6 inches of Specified Sand at the edges of the GSF module.
- 6 inches of Specified Sand at the beginning and end of each GSF Row.
- 6 inches of Specified Sand directly below the GSF module.
- 6 inches of cover soil material above the 4-inch distribution pipe

3.0.4 VERTICAL SEPARATION TO SEASONAL HIGH-WATER TABLE OR LIMITING LAYER: The guidelines allow for the Vertical Separation from bottom of the 6 inches of sand under the GSF units to the restrictive layer.

3.0.5 DISTRIBUTION BOX: Parallel distribution is preferred. Sequential distribution may be utilized for sloping sites.

3.0.6 PARALLEL DISTRIBUTION: Parallel distribution is the preferred method of application to a gravity or pump to gravity system. It encourages equal flows to each of the lines in the system. It is recommended for most bed systems.

3.0.7 ROWS REQUIRED: All bed systems shall have a minimum of one row of modules. Typical bed installations require 2 rows of modules.

3.0.8 ROW LENGTH: The maximum gravity lateral run shall not exceed 100 feet. If a lateral is supplied from the center, the total length shall not exceed 200 feet (100 feet to each side).

3.0.9 EQUAL LENGTH: Eljen recommends rows are of equal length in order to provide equal distribution.

3.0.10 DISPERSAL AREA: Dispersal area requirements are met by total length and width of the bed. Example: 12 feet wide x 60 feet = 720 square feet of dispersal area.

3.0.11 MINIMUM SLOPE REQUIREMENTS: Maintain a minimum 2:1 slope or gentler for all slopes off the cell area.

3.0.12 SYSTEM LENGTH AND WIDTH: Best engineering practices should be used when constructing the bed systems. Eljen recommends the dimensions of the bed shall be as long and narrow as the site allows.

3.0 Bed Design and Installation

3.0.13 BED DESIGN: Evenly distribute the bed laterals in the basal area for level bed installations. A minimum separation distance between laterals for A42's is 3 feet. On sloping bed installations over 5% slope, move the uppermost lateral to 2 feet from the upper cell edge, and space the rows afterwards at 3 feet lateral to lateral.

3.0.14 SEPARATE SUBSURFACE REPLACEMENT AREA: There is no requirement for a separate subsurface replacement area.

3.0.15 DOWNSLOPE EXTENSION: Downslope extensions of 3 ft are required for all systems and are measured from the downslope unit edge (the 6" sand shoulder is included in the extension). It is part of the basal area calculation and typically is needed for systems in faster soils.

3.1 Level Bed Design Example

Bed Example:

House size:	3 Bedrooms
Design Flow:	300 gpd
Soil Description:	Silty Clay Loam with 45 mpi perc
Absorption Field Type:	Bed

Determine Minimum Basal Area and Units Required

Lookup the minimum basal area from Table 2:

Texture	Percolation Rate (mpi)	GSF System Application Rate (gpd/ft2)	Minimum Basal Area Required				
			2 Bedrooms 225 gpd	3 Bedrooms 300 gpd	4 Bedrooms 350 gpd	5 Bedrooms 400 gpd	Each Additional Bedroom 50 gpd
Clay loam, silty clay loam	31 - 50	0.6	375	500	584	667	84

Lookup the minimum units required from Table 3:

Texture	Percolation Rate (mpi)	GSF System Application Rate (gpd/ft2)	Minimum Units Required				
			2 Bedrooms 225 gpd	3 Bedrooms 300 gpd	4 Bedrooms 350 gpd	5 Bedrooms 400 gpd	Each Additional Bedroom 50 gpd
Very fine sand, sandy clay loam, silt loam	16 - 30	0.8	15	20	24	30	6

Units per Rows

Total units ÷ Number Rows = Units per Row

2 Rows

20 Units ÷ 2 Rows = 10 Units per Row

3 Rows

20 Units ÷ 3 Rows = 6.7, round to 7 Units per Row

System Length

Units per Row x 4 ft/unit +1 = System Length

2 Rows

10 Units per Row x 4 ft/unit + 1 = 41 ft

3 Rows

7 Units per Row x 4 +1 = 29 ft

System Width

Minimum Basal Area ÷ System Length = System Width

2 Rows (Minimum Width = 2 Rows x 3 ft = 6 ft)

500 ft^2 ÷ 41 ft = 12.2, round to 12.5 ft

3 Rows (Minimum Width = 3 Rows x 3 ft = 9 ft)

500 ft^2 ÷ 29 ft = 17.25, round to 18 ft

Lateral to Lateral Spacing (Level Site)

System Width ÷ Number of Rows = Lateral to Lateral Spacing

2 Rows

12.5 ft ÷ 2 rows = 6.25 ft

3 Rows

18 ft ÷ 3 rows = 6 ft

3.1 Level Bed Design Example

Lateral to Edge of System Spacing (Level Site)

Lateral to Lateral Spacing ÷ 2 = Lateral to Edge of System Spacing

2 Rows		**3 Rows**	
6.25 ft ÷ 2 =	3.125 ft	6 ft ÷ 2 =	3 ft

2 Rows

System Length	41 ft
System Width	12.5 ft
Number of Units	20 A42 Units
Lateral to Lateral Spacing	6.25 ft
Lateral to Edge Spacing	3.125 ft
Min. System Area	512.5 ft^2

3 Rows

System Length	29 ft
System Width	18 ft
Number of Units	21 A42 Units
Lateral to Lateral Spacing	6 ft
Lateral to Edge Spacing	3 ft
Min. System Area	522 ft^2

FIGURE 8: PLAN VIEW – BED SYSTEM

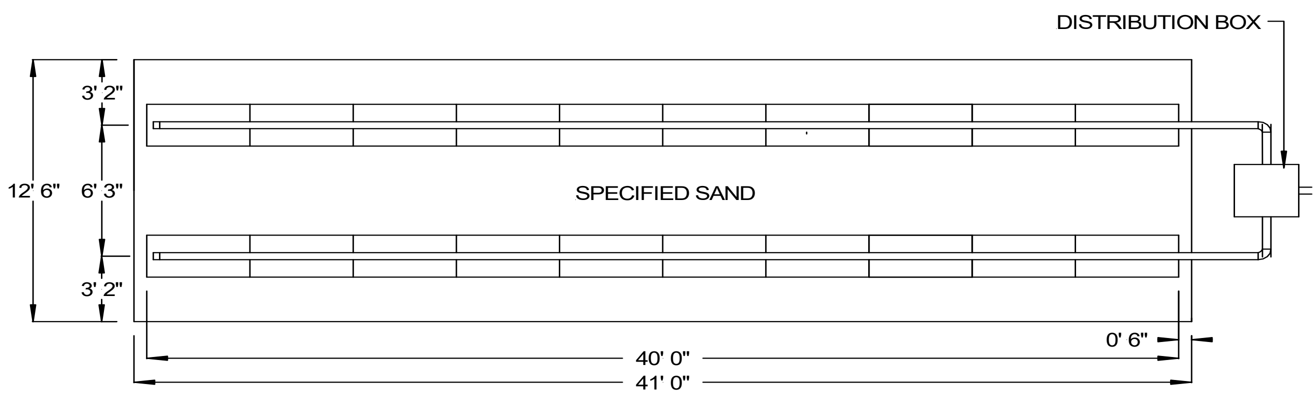
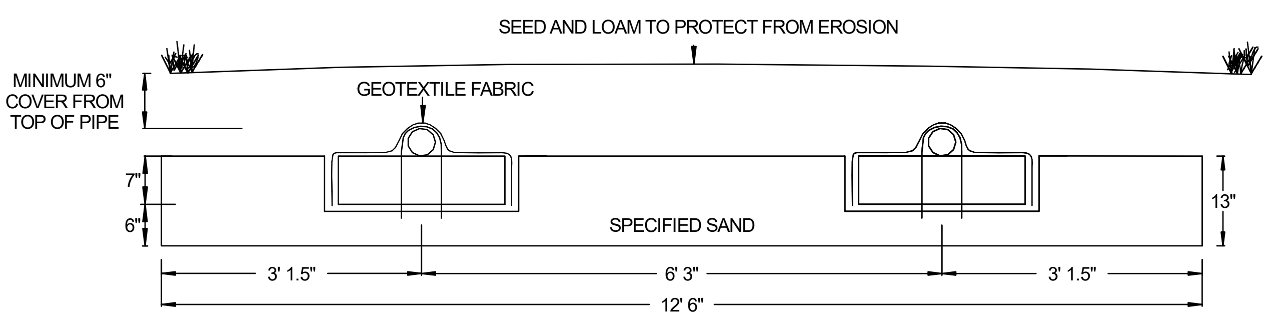


FIGURE 9: SECTION VIEW – 2 LATERAL BED SYSTEM



3.2 Sloped Bed Design Example

Bed Example:

House size:	3 Bedrooms
Design Flow:	300 gpd
Soil Description:	Sandy Clay with 65 mpi perc
Slope:	6%
Absorption Field Type:	Bed

Determine Minimum Basal Area and Units Required

Lookup the minimum basal area from Table 2:

Texture	Percolation Rate (mpi)	GSF System Application Rate (gpd/ft2)	Minimum Basal Area Required				
			2 Bedrooms 225 gpd	3 Bedrooms 300 gpd	4 Bedrooms 350 gpd	5 Bedrooms 400 gpd	Each Additional Bedroom 50 gpd
Sandy clay	51 - 79	0.266	846	1128	1316	1504	188

Lookup the minimum units required from Table 3:

Texture	Percolation Rate (mpi)	GSF System Application Rate (gpd/ft2)	Minimum Units Required				
			2 Bedrooms 225 gpd	3 Bedrooms 300 gpd	4 Bedrooms 350 gpd	5 Bedrooms 400 gpd	Each Additional Bedroom 50 gpd
Sandy clay	51 - 79	0.266	18	24	28	32	9

Units per Row

Total units ÷ Number Rows = Units per Row

2 Rows

24 Units ÷ 2 Rows = 12 Units per Row

3 Rows

24 Units ÷ 3 Rows = 8 Units per Row

System Length

Units per Row x 4 ft/unit +1 = System Length

2 Rows

12 Units per Row x 4 ft/unit + 1 = 49 ft

3 Rows

8 Units per Row x 4 +1 = 33 ft

System Width

Minimum Basal Area ÷ System Length = System Width

2 Rows (Minimum Width = 2 Rows x 3 ft = 6 ft)

1,128 ft^2 ÷ 49 ft = 23.02 ft, round to 23.5 ft

3 Rows (Minimum Width = 3 Rows x 3 ft = 9 ft)

1,128 ft^2 ÷ 33 ft = 34.18, round to 34.5 ft

3.2 Sloped Bed Design Example

Lateral to Lateral Spacing (Sloping Site)	3 ft
Lateral to Edge of System Spacing (Sloping Site)	1.5 ft

Downslope Edge Extension

Pick Max: Minimum Width + 2.5 ft or System Width

2 Rows

6 ft + 2.5 ft = 8.5 ft

System Width = 23.5 ft

3 Rows

9 ft + 2.5 ft = 11.5 ft

System Width = 34.5 ft

2 Rows

System Length	49 ft
System Width	23.5 ft
Number of Units	24 A42 Units
Lateral to Lateral Spacing	3 ft
Lateral to Edge Spacing	1.5 ft
Min. System Area	1,151.5 ft^2

3 Rows

System Length	33 ft
System Width	34.5 ft
Number of Units	24 A42 Units
Lateral to Lateral Spacing	3 ft
Lateral to Edge Spacing	1.5 ft
Min. System Area	1,138 ft^2

FIGURE 10: PLAN VIEW – A42 – BED SYSTEM – SLOPING SYSTEM

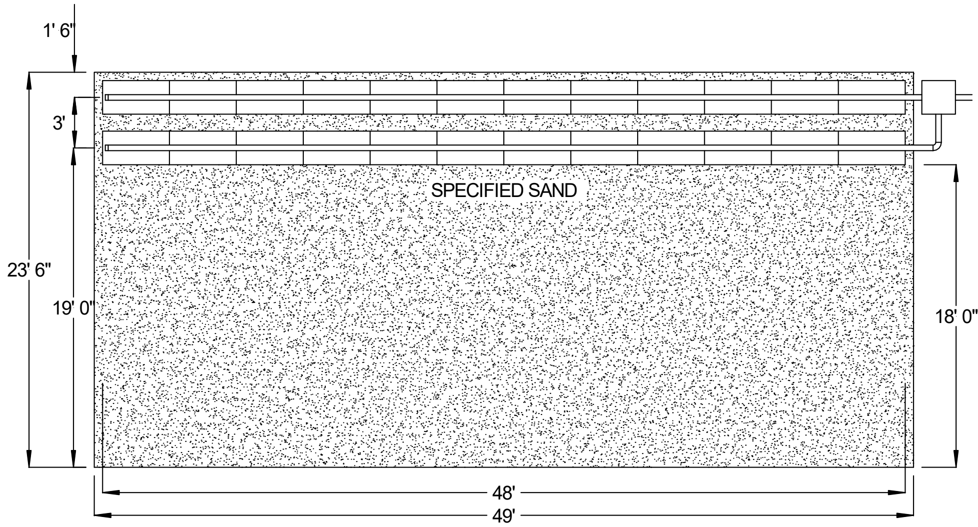
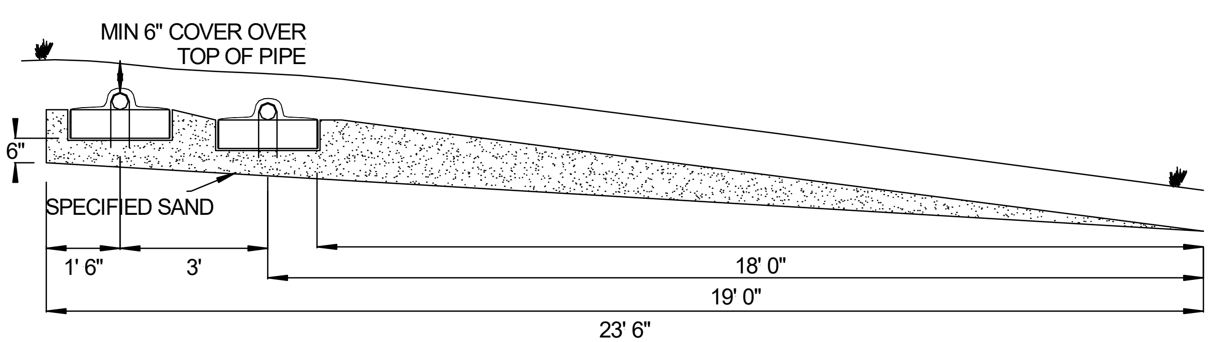


FIGURE 11: CROSS SECTION VIEW– A42 – BED SYSTEM – SLOPING SYSTEM



3.3 Bed Design Installation Steps

1. Ensure all components leading to the GSF system are installed properly. Septic tank effluent filters are required with the GSF system.

2. Determine the number of GSF Modules required using the bed sizing example.

3. Prepare the site. Do not install a system in saturated ground or wet soils that are smeared during excavation. Keep machinery off infiltrative areas.

4. Plan all drainage requirements above (up-slope) of the system. Set soil grades to ensure that storm water drainage and ground water is diverted away from the absorption area once the system is complete.

5. Excavate the bed absorption area; scarify the receiving layer to maximize the interface between the native soil and specified sand.

6. Minimize walking in the absorption area prior to placement of the specified sand to avoid soil compaction.

7. Place specified sand in a 6” lift, stabilize by foot, a hand-held tamping tool or a portable vibrating compactor. The stabilized height below the GSF module must be level at 6”.

8. Place GSF modules with **PAINTED STRIPE FACING UP**, end to end on top of the specified sand along their 4-foot length.

9. A standard 4-inch perforated pipe, SDR 35 or equivalent, is centered along the modules 4-foot length. Orifices are set at the 4 & 8 o’clock position.

10. All 4-inch pipes are secured with manufacturers supplied wire clamps, one per module.

11. (Pressure Distribution Systems) The pressure pipe orifices are set at the 12 o’clock position as shown in Figure 17. Orifice shields are placed over the lateral. Each pressure lateral will have a drain hole at the 6 o’clock position. Each pressure lateral shall have a clean out at the end of the trench. Refer to Section 6 for guidelines on how to use pressure distribution.

12. ***Cover fabric substitution is not allowed.*** The installer should lay the Eljen provided geotextile cover fabric lengthwise down the row, with the fabric fitted to the perforated pipe on top of the GSF modules. Fabric should be neither too loose, nor too tight. The correct tension of the cover fabric is set by:
    a. Spreading the cover fabric over the top of the module and down both sides of the module with the cover fabric tented over the top of the perforated distribution pipe.
    b. Place shovelfuls of Specified Sand directly over the pipe area allowing the cover fabric to form a mostly vertical orientation along the sides of the pipe. Repeat this step moving down the pipe.

13. Place 6 inches of Specified Sand along both sides of the modules edge. A minimum of 6 inches of Specified Sand is placed at the beginning and end of each module row. A minimum of 12 inches of Specified Sand is placed in between module rows.

14. Complete backfill with a minimum of 6 inches of approved cover material measured from the top of the distribution pipe. Backfill exceeding 18 inches over the top of the unit requires venting at the far end of the bed. Use well graded native soil fill that is clean, porous and devoid of large rocks. Do not use wheeled equipment over the system. A light track machine may be used with caution, avoiding crushing or shifting of pipe assembly.

15. Divert surface runoff from the system. Finish grade to prevent surface ponding. Topsoil and seed system area to protect from erosion.

4.0 Mound Installation Sizing and Guidelines

4.0.1 MOUND REFERENCE: The following sizing and guidelines provide the dimensions of the dispersal bed for your mound. Consult the local regulations for more information on the construction of the mound system.

4.0.2 MOUND EXAMPLE:

House size:	3 bedrooms
Slope of site:	4%
Berm Slopes:	3:1
Daily Design Flow:	300 gpd
Soil Application Rate (SAR) from Table 2:	0.6 gpd/ft^2

FIGURE 12: CROSS SECTION – MOUND SYSTEM

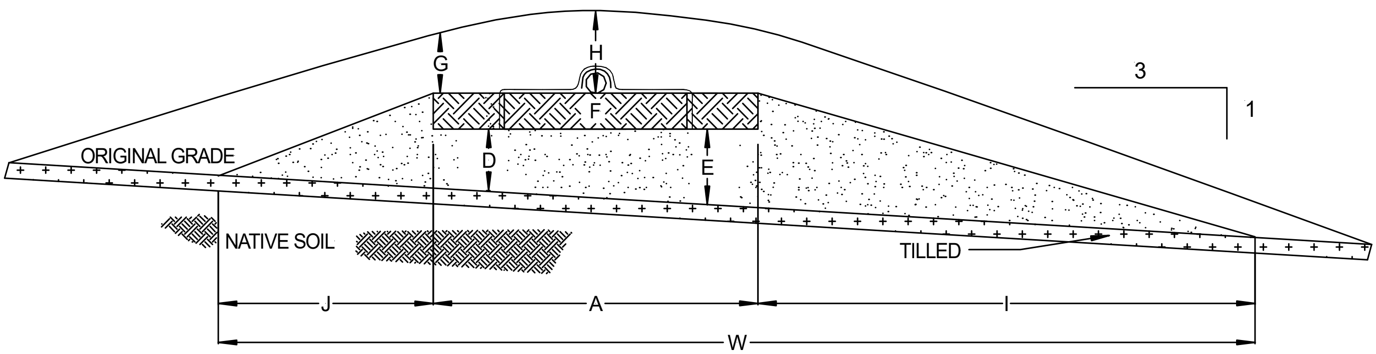
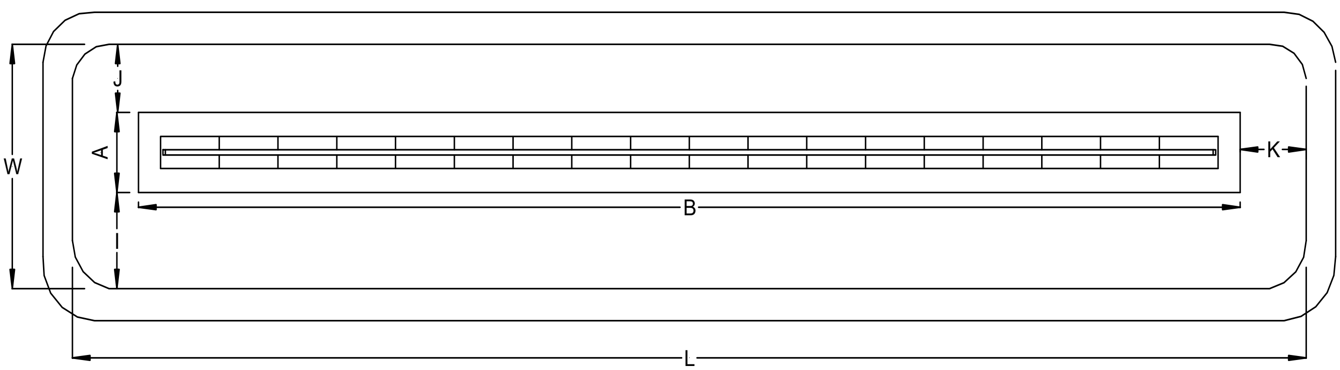


FIGURE 13: PLAN VIEW – MOUND SYSTEM



A – Dispersal bed width (accounts for sand) – **Minimum 3 ft; Maximum 10 ft**
B – Dispersal bed length (accounts for sand)
D – Up slope mound fill depth – **Minimum 1 ft**
E – Down slope mound fill depth – **Minimum 1 ft**
F – Cell Height – **Constant 0.583 ft**
G – Height of cover over edge of cell
H – Height of cover over center of cell
I – Down slope measurement from distribution cell
J – Up slope measurement from distribution cell
K – End slope length
L – Length
W – Width

4.0.3 DETERMINE THE MAX HYDRAULIC LINEAR LOADING RATE: The hydraulic linear loading rate (HLLR) is defined as the amount of effluent (gallons) applied per day per linear foot of the system (gpd/lf). The design linear loading rate is a function of effluent movement rate away from the system and the direction of movement away from the system. If the movement is primarily vertical, then the linear loading rate is not as critical as if the flow is primarily horizontal. Other factors such as gas transfer from beneath the absorption area suggests that the absorption area width be relatively small (Tyler et al, 1986). It is difficult to estimate the linear loading rate for a variety of soil and flow conditions but based on the authors' experience "good estimates" can be given. If the flow away from the system is primarily vertical, then the linear loading rate can be high but should be in the range of 8 to 10 gpd/lf otherwise the absorption area is excessively wide, especially for the slower permeable soils such as silt loams. However, if the flow is shallow and primarily horizontal then the linear loading rate should be in the range of 3 -4 gpd/lf. This approach will result in long and narrow systems.

HLLR – 3.0 gpd/lf

4.0.4 CALCULATE VARIABLES:

Step 1: Determine Daily Design Flow (DDF) 300 gpd

Step 2: Determine Linear Loading Rate (LLR) 3.0 gpd/lf

Step 3: Sand Fill Loading Rate (SLR) 1.0 gpd/ft^2 (constant)

Step 4: Absorption Area Width (A)

A = LLR ÷ SLR
= 3.0 gpd/lf ÷ 1.0 gpd/ft^2
= 3 ft, **Minimum 3 ft**
= 3 ft

Step 5: Absorption Area Length (B)

B = DDF ÷ LLR
= 300 gpd ÷ 3.0 gpd/lf
= 100 ft

Step 6: Basal Width (A + I)

A + I = LLR ÷ SAR
= 3.0 gpd/lf ÷ 0.6 gpd/ft^2
= 5 ft
Since A = 3 ft
I = (A + I) – A
= 5 ft – 3 ft
= 2 ft

Step 7: Mound Fill Depth (D)

D = Minimum 1 ft
= 1 ft

Step 8: Downslope Mound Fill Depth (E)

E = D + 0.04 x (A)
= 1 ft + 0.04 x (3 ft)
= 1 ft + 0.12 ft
= 1.12 ft

Step 9: Determine Mound Depths (F), (G) and (H)

F = 0.583 ft (constant)

G = 0.5 ft (typical)

H = 1 ft (typical)

Step 10: Determine the up-slope width (J)

J = 3 x (D + F +G) x (Up Slope Correction Factor)

Up Slope Correction Factors																										
Slope %	0%	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%	17%	18%	19%	20%	21%	22%	23%	24%	25%
Correction Factor	1.00	0.97	0.94	0.92	0.89	0.88	0.85	0.83	0.80	0.79	0.77	0.75	0.73	0.72	0.71	0.69	0.68	0.66	0.65	0.64	0.62	0.61	0.60	0.59	0.58	0.57

= 3 x (1 ft + 0.583 ft + 0.5 ft) x 0.89
= 3 x (2.083 ft) x 0.89
= 5.56 ft

Step 11: Determine the end-slope length (K)

K = 3 x ((D + E) ÷ 2) + F + H)
= 3 x ((1 ft + 1.12 ft) ÷ 2) + 0.583 ft + 1 ft)
= 3 x ((2.12 ft) ÷ 2) + 0.583 ft + 1 ft)
= 3 x ((1.06 ft) + 0.583 ft + 1 ft)
= 3 x (2.643 ft)
= 7.93 ft

Step 12: Determine the down-slope width (I)

I = 3 x (E + F +G) x (Down Slope Correction Factor)

Down Slope Correction Factors																										
Slope %	0%	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%	17%	18%	19%	20%	21%	22%	23%	24%	25%
Correction Factor	1.00	1.03	1.06	1.10	1.14	1.18	1.22	1.27	1.32	1.38	1.44	1.51	1.57	1.64	1.72	1.82	1.92	2.04	2.17	2.33	2.50	2.70	2.94	3.23	3.57	4.00

= 3 x (1.12 ft + 0.583 ft + 0.5 ft) x 1.14
= 3 x (2.203 ft) x 1.14
= 7.53 ft

Step 13: Determine the end slope length (L + W)

L = B + 2K
= 100 ft + 2 x 7.93 ft
= 100 ft + 15.86 ft
= 115.86 ft

W = I + A + J
= 7.53 ft + 3 ft + 5.56 ft
= 16.09 ft

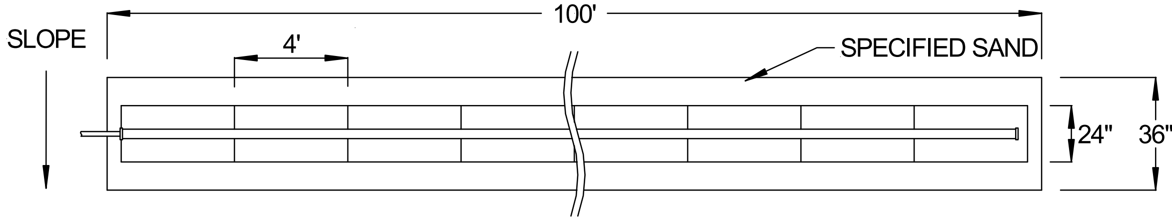
4.0.5 BED CELL CONSTRUCTION –
Width – 3 ft
Length – 100 ft

Minimum A42s needed for this system: 3 bedrooms x 6 A42s/bedroom = 18 A42 Modules

Units per row: $\frac{\text{Length} - 1}{4\ \text{ft/module}}$

$\frac{100\ \text{ft} - 1\ \text{ft}}{4\ \text{ft/module}}$ = 24.75, round down to 24 A42 Modules

FIGURE 14: PLAN VIEW – DISTRIBUTION CELL MOUND SYSTEM



4.0.6 EFFLUENT DISTRIBUTION: The system must be a low-pressure distribution system.

4.0.7 MOUND CONSTRUCTION–
Overall Width (with slopes) – 16.09 ft
Overall Length (with slopes) – 115.86 ft

FIGURE 15: SECTION VIEW – MOUND SYSTEM

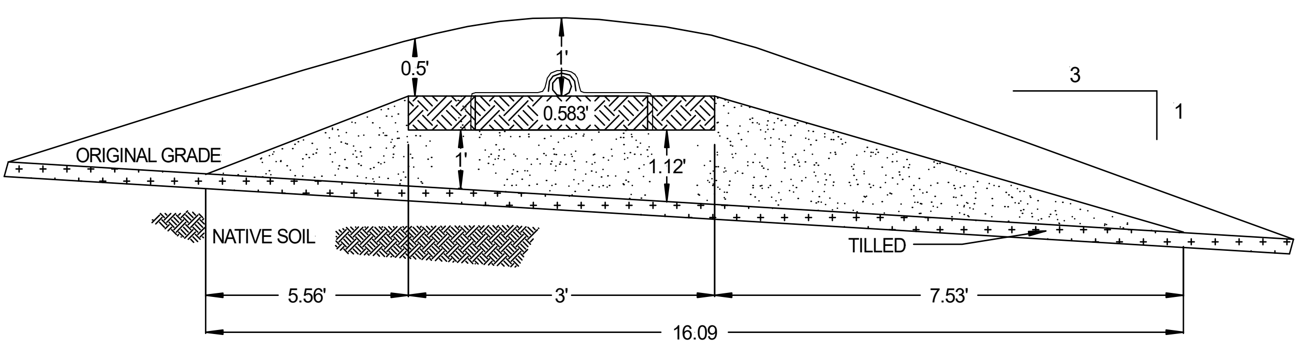
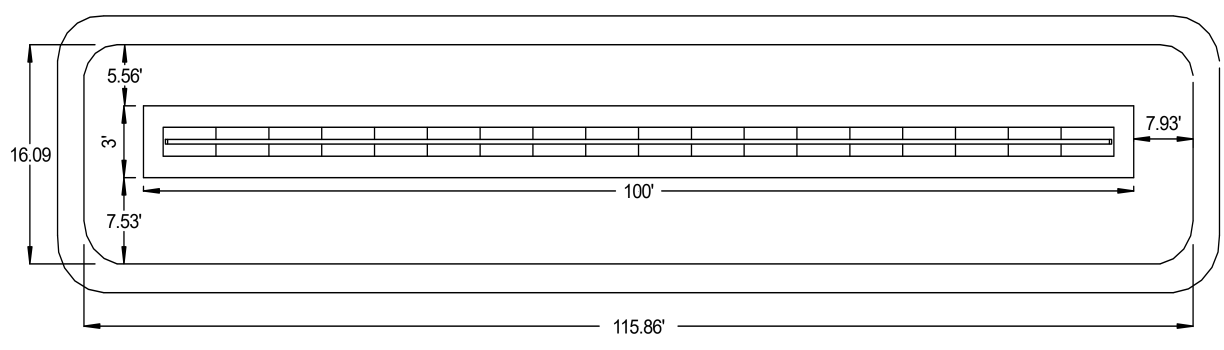


FIGURE 16: PLAN VIEW – MOUND SYSTEM



4.1 Mound Design Installation

1. Ensure all components leading to the GSF system are installed properly. Septic tank effluent filters are required with the GSF system.

2. Determine the number of GSF Modules required using the sizing formula.

3. Prepare the site. Do not install a system on saturated ground or wet soils that are smeared during preparation. Keep machinery off infiltrative areas.

4. Plan all drainage requirements above (up-slope) of the system. Set soil grades to ensure that storm water drainage and ground water is diverted away from the absorption area once the system is complete.

5. Remove the organic soil layer. Scarify the receiving layer to maximize the interface between the native soil and Specified Sand. Minimize walking in the absorption area prior to placement of the Specified Sand to avoid soil compaction.
6. Place fill material meeting local requirements (or Specified Sand requirements) onto the soil interface as you move down the excavated area. Place specified sand in 6" lifts, stabilize by foot, a hand held tamping tool or a portable vibrating compactor. The stabilized height below the GSF module must shall meet the mound design requirements.
7. Place GSF modules with **PAINTED STRIPE FACING UP**, end to end on top of the specified sand along their 4-foot length.

8. A standard perforated 4-inch distribution pipe is centered along the modules 4-inch length. Orifices are set at the 4 & 8 o'clock position.

9. All distribution pipes are secured with manufacturers supplied wire clamps, one per module.

10. Insert a PVC Sch. 40 pressure pipe (size per design and code) into the standard perforated distribution pipe. The pressure pipe orifices are set at the 12 o'clock position as shown in Figure 17. Each pressure lateral will have a drain hole at the 6 o'clock position. Each pressure lateral shall include sweeping cleanouts at the terminal ends and be accessible from grade.

    It is strongly recommended to install a 4-inch vent onto the distribution pipe. Distribution pipes can be connected to one vent or use one vent per distribution line.

11. ***Cover fabric substitution is not allowed.*** The installer should lay the Eljen provided geotextile cover fabric lengthwise down the row, with the fabric fitted to the perforated pipe on top of the GSF modules. Fabric should be neither too loose, nor too tight. The correct tension of the cover fabric is set by:
    a. Spreading the cover fabric over the top of the module and down both sides of the module with the cover fabric tented over the top of the perforated distribution pipe.
    b. Place shovelfuls of Specified Sand directly over the pipe area allowing the cover fabric to form a mostly vertical orientation along the sides of the pipe. Repeat this step moving down the pipe.

12. Ensure there is 6 inches of specified sand surrounding the GSF modules in the mound. Slope the sand away from the mound as described on the plan.

13. Complete backfill with a minimum of 12 inches of cover material measured from the top of the module. Use well graded native soil fill that is clean, porous and devoid of large rocks. Do not use wheeled equipment over the system. A light track machine may be used with caution, avoiding crushing or shifting of pipe assembly. Divert surface runoff from the system. Finish grade to prevent surface ponding. Topsoil and seed system area to protect from erosion.

14. Divert surface runoff from the system. Finish grade to prevent surface ponding. Topsoil and seed system area to protect from erosion.

5.0 Dosing Distribution Requirements

5.0.1 DOSING DESIGN CRITERIA: Dosing volume must be set to deliver a maximum of **3 gallons per Module** per dosing cycle. Head loss and drain back volume must be considered in choosing the pump size and force main diameter.

6.0 Pressure Distribution Requirements

6.0.1 PRESSURE DISTRIBUTION: Dosing with small diameter pressurized laterals is acceptable for GSF systems. The pipe networks must be engineered and follow principles established for pressure distribution. Flushing ports are required to maintain the free flow of effluent from orifices at the distal ends of each lateral. Contact Eljen's Technical Resource Department at 1-800-444-1359 for more information on pressure distribution systems

Standard procedures for design of pressure distribution networks apply to the GSF filter. Minimum orifice and lateral pipe size are based on design. A drain hole is required at the end of each row at the 6 o'clock position of each pressure lateral for drainage purposes. The lateral pipe network is placed within a standard 4-inch perforated pipe. The perforation in the 4-inch outer pipe are set at the 4 and 8 o'clock position, the drilled orifices on the pressure pipe are set to spray at the 12 o'clock position directly to the top of the 4-inch perforated pipe as shown below.

Orifice shields are an acceptable replacement for the 4" pipe.

6.0.2 DOSING DESIGN CRITERIA: For all pump systems; use a maximum of 3 gallons per dose per A42 module in the system. Adjust pump flow and run time to achieve the above maximum dose. Use a minimum pump run time of one minute. Longevity of currently available effluent pumps are not affected by shorter run times. Choose force main diameter to minimize percentage of dose drain back.

FIGURE 17: PRESSURE PIPE PLACEMENT

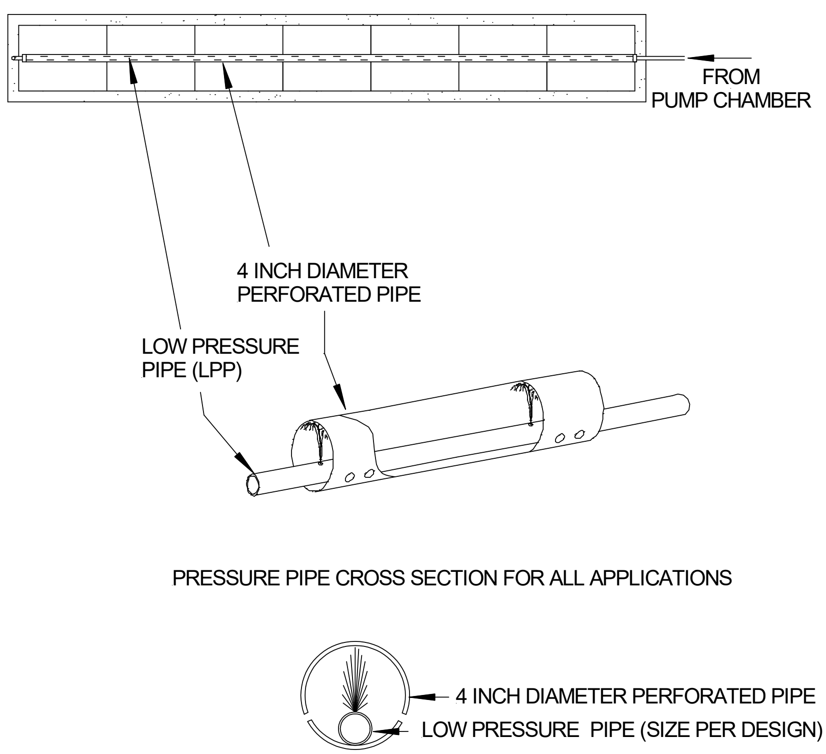


FIGURE 18: PRESSURE CLEAN OUT

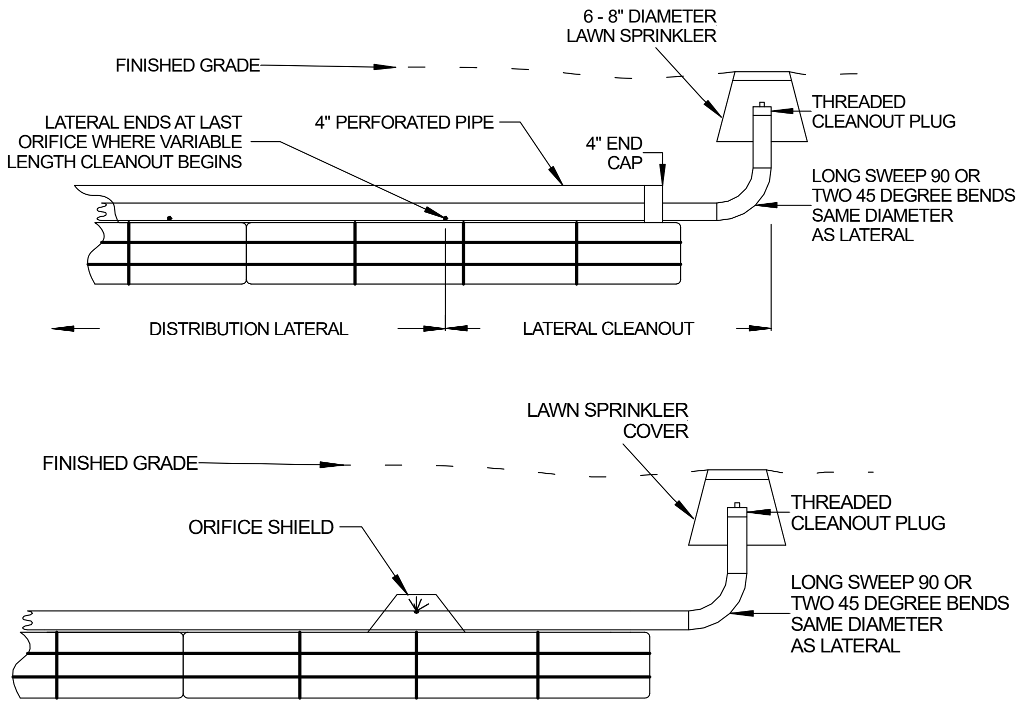
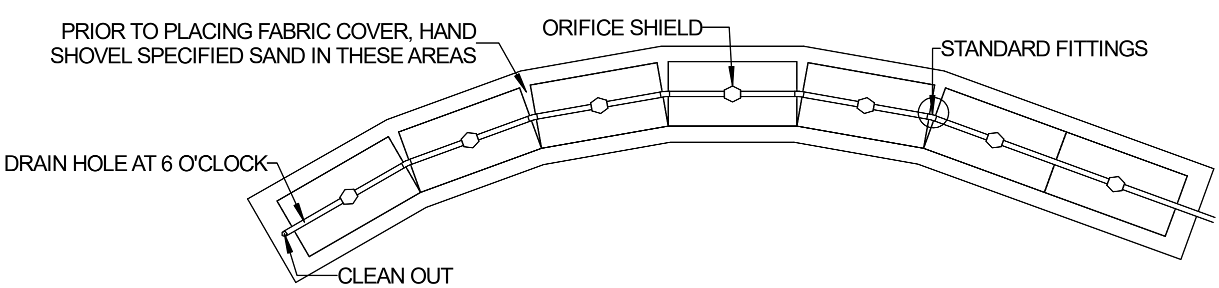


FIGURE 19: CONTOURED TRENCH PRESSURE DISTRIBUTION USING ORIFICE SHIELDS



GSF Pressure Distribution trench placed on a contour or winding trenches to maintain horizontal separation distances.

7.0 Pump Controls

Pump controlled systems will include an electrical control system that has the alarm circuit independent of the pump circuit controls and components that are listed by UL or equivalent, is located outside, within line of sight of the dosing tank and is secure from tampering and resistant to weather (minimum of NEMA4X).

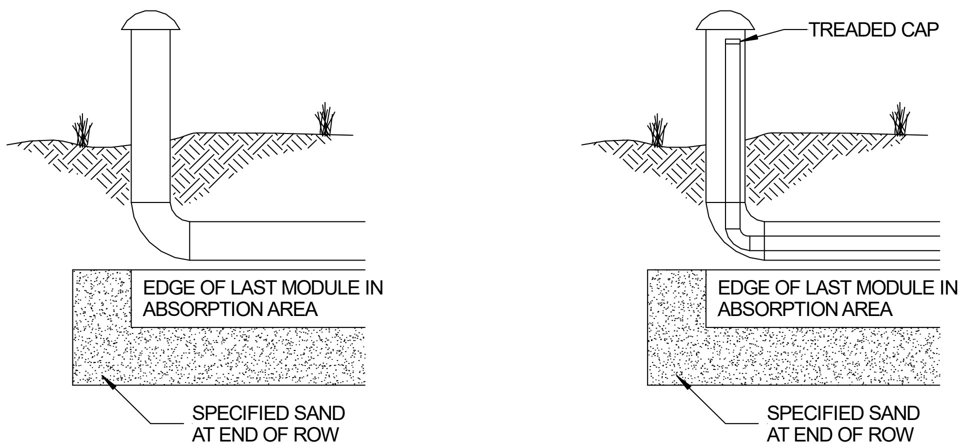
The control panel shall be equipped with both audible and visual high liquid level alarms installed in a conspicuous location. Float switches shall be mounted independent of the pump and force main so that they can be easily replaced and/or adjusted without removing the pump.

8.0 System Ventilation

8.0.1 SYSTEM VENTILATION: Air vents are required on all absorption systems located under impervious surfaces or systems **with *more than 18 inches of cover material*** as measured from the top of the GSF module to finished grade. This will ensure proper aeration of the modules and sand filter. The GSF has aeration channels between the rows of GSF modules connecting to cuspations within the GSF modules. Under normal operating conditions, only a fraction of the filter is in use. The unused channels remain open for intermittent peak flows and the transfer of air.

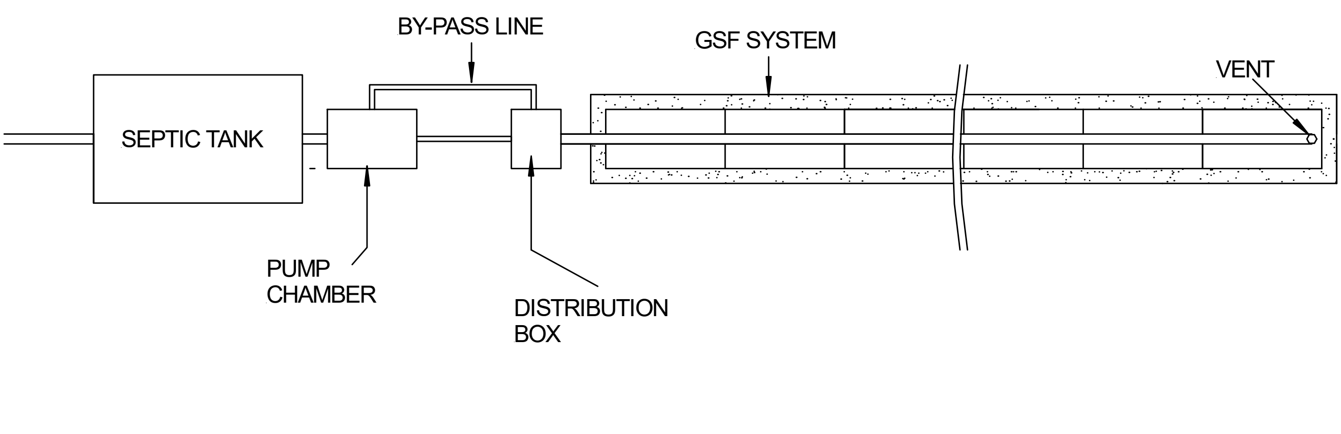
8.0.2 VENT PIPE FOR GRAVITY AND LOW-PRESSURE SYSTEMS: Systems with over 18" of cover over the top of the modules require a vent. If the system is a low-pressure distribution system, ensure that the LPP clean outs are located in the vent for easy access.

FIGURE 20: VENT LAYOUTS FOR GRAVITY AND LOW-PRESSURE SYSTEMS



8.0.3 AIR BY-PASS LINE: Systems with over 18" of cover that are pumped or pressure dosed require an air by-pass line to continue flow from the low vent on the system to the high vent of the house. Simply plumb an airline from the distribution system back to the pump chamber or septic tank to provide unobstructed flow.

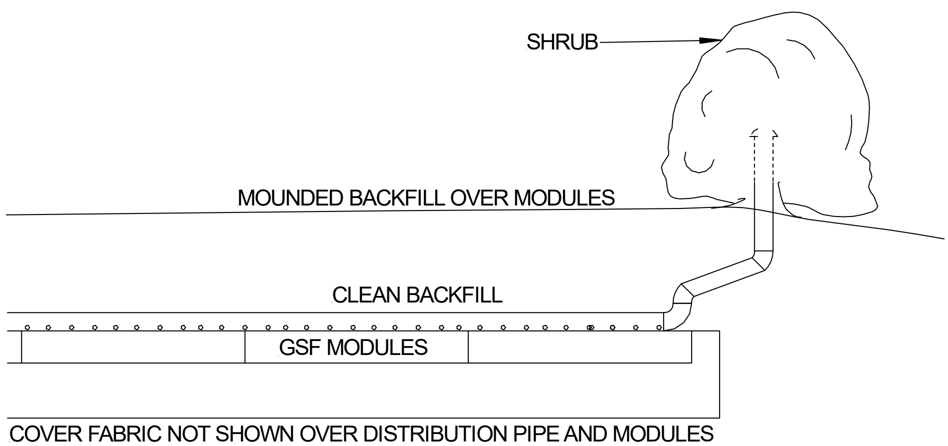
FIGURE 21: AIR BY-PASS LINE PLAN VIEW FOR VENTING OF PUMPED SYSTEMS



8.0 System Ventilation

8.0.4 VENTILATION PLACEMENT: In a GSF system, the vent is usually a 4-inch diameter pipe extended to a convenient location behind shrubs, as shown in the figure below. Corrugated pipe may be used. If using corrugated pipe, ensure that the pipe does not have any bends that will allow condensation to pond in the pipe. This may close off the vent line. The pipe must have an invert higher than the system so that it does not drain effluent.

FIGURE 22: GSF WITH 4" VENT EXTENDED TO CONVENIENT LOCATION



COMPANY HISTORY

Established in 1970, Eljen Corporation created the world's first prefabricated drainage system for foundation drainage and erosion control applications. In the mid-1980s, we introduced our Geotextile Sand Filter products for the passive advanced treatment of onsite wastewater in both residential and commercial applications. Today, Eljen is a global leader in providing innovative products and solutions for protecting our environment and public health.

COMPANY PHILOSOPHY

Eljen Corporation is committed to advancing the onsite industry through continuous development of innovative new products, delivering high quality products and services to our customers at the best price, and building lasting partnerships with our employees, suppliers, and customers.

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